Short Communications

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Seasonal Diet of the Aplomado Falcon (*Falco femoralis*) in an Agricultural Area of Araucanía, Southern Chile

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The Aplomado Falcon (*Falco femoralis*) is distributed from southwestern United States to Tierra del Fuego Isla Grande in southern Argentina and Chile. Aplomados inhabit open areas such as savannas, desert grasslands, Andean and Patagonian steppes, and tree-lined pastures, from coastal plains up to 4000 m in the Andes (Brown and Amadon 1968, de la Peña and Rumboll 1998). In the United States, the Aplomado Falcon is listed as endangered (Shull 1986) due to the historical modification of its habitats and cumulative effects of DDT (Kiff et al. 1980, Hector 1987). In contrast, the Chilean population may be increasing. Forest conversion to agricultural lands have increased hunting habitat and prey availability for this species (Jaksic and Jiménez 1986). Nonetheless, the Aplomado Falcon is rare in southern Chile (Jaksic and Jiménez 1986) and it is protected legally (República de Chile 1996, 1998).

The biology of the Aplomado Falcon is little known. Breeding biology, survival, movements, and habitat use have recently been reported (Pérez et al. 1996, Montoya et al. 1997). Studies on Aplomado Falcon summer diet have been conducted in northern Mexico (Hector 1981, 1985), northern Chile (Jiménez 1993), and southeastern Argentina (Bó 1999). Some recent anecdotal descriptions of predation on crayfish (*Combarus diogenes;* Clark et al. 1989), Spotted Tinamous (*Nothura maculosa;* Silveira et al. 1997), and lizards (*Liolaemus lineomaculatus;* Trejo et al. 2003) have also been published. Piracy also has been documented as an important foraging method for obtaining mammal prey from other raptors (Brown et al. 2003). However, seasonal differences in diet have not been described. Here, we report the seasonal diet of Aplomado Falcons and correlate it with prey abundance in the Araucanían agricultural area in southern Chile.

Study Area and Methods

Our study area was the Tricauco Farm (200 ha), 6 km south of Traiguén city (38°14′S, 72°38′W) in the Araucanía region, southern Chile. The landscape is comprised mainly of wheat and oat crops, scattered pasture and sedge-rush (*Carex-Juncus* spp.) marshes, small plantations of nonnative *Pinus* spp. and *Eucalyptus* spp., and remnants of the native southern beech (*Nothofagus* spp.) forest. The climate is moist-temperate with a Mediterranean influence (di Castri and Hajek 1976). Mean annual rainfall and temperature are 1400 mm and 12°C, respectively.

From August (austral winter) to December (austral spring–summer) 1997, we collected 65 pellets under trees and fence posts used as pluck sites by at least one pair of Aplomado Falcons. We collected 40 pellets during winter and 25 during spring–summer. A few prey remains were also collected beneath pluck sites during the spring–summer period. Although pellets could be confused with those of the sympatric Cinereous Harrier (*Circus cinereus*) or American Kestrel (*Falco sparverius*), we only saw Aplomado Falcons at the collection sites during our study. Perches identified as those of Cinereous Harriers and American Kestrels were located away from (1.0–1.5 km) known Aplomado Falcon pluck sites. In addition, Aplomado Falcons are aggressive toward other raptors (Hector 2000, Brown et al. 2003).

Avian prey were identified mainly on the basis of feathers, using two complementary methods: microscopic analysis of feather structures such as nodes and barbules (Reyes 1992), and a comparison of feather coloration patterns with voucher specimens deposited in the Zoology Department of the Universidad Austral of Chile at Valdivia. We assumed that species identified in a pellet represented only one individual. Small mammals were identified and quantified on the basis of skulls or dentition following Pearson (1995). Insects were identified and quantified by head capsules or elytra following Peña (1986). We identified prey items to the finest possible taxonomic category. Biomass contribution was estimated following Marti (1987). Masses for small mammal and avian prey followed Figueroa and Corales (1999). Insect masses were based on the authors' unpublished data. We assumed that unidentified prey masses were similar to the mean mass of the most closely related identified taxon.

Concurrent to the collection of pellets, we evaluated bird and small mammal prey abundance in the field. We estimated bird abundance using parallel, fixed-band (2000 m long, 100 m wide) line transects (Bibby et al. 1993) placed 400 m apart in the hunting areas of falcons.

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Table 1. Diet of the Aplomado Falcon (*Falco femoralis*) determined from pellets in an agricultural area of the Araucanía region, southern Chile.

			WINTER		SPRING–SUMMER		ANNUAL	
PREY SPECIES	MASS[a] (g)	DIET[b]	PERCENT FREQUENCY	PERCENT BIOMASS	PERCENT FREQUENCY	PERCENT BIOMASS	PERCENT FREQUENCY	PERCENT BIOMASS
Mammals			42.5	15.9	2.4	0.7	27.8	9.7
Rodentia								
Abrothrix olivaceus	23	O	12.3	4.6	0	0	7.9	2.7
Oligoryzomys longicaudatus	26	G (F)	6.9	2.9	0	0	4.3	1.7
Mus domesticus	21	O	6.9	2.3	0	0	4.3	1.4
Unidentified rodents	23		16.4	6.1	2.4	0.7	11.3	3.9
Birds			57.5	84.1	88.1	99.2	68.7	90.2
Columbiformes								
Columba araucana	300	F (G)	2.7	13.3	4.7	19.2	3.5	15.7
Zenaida auriculata	137	G	13.7	30.4	14.4	26.3	13.9	28.7
Passeriformes								
Turdus falcklandii	90	F (I)	17.8	26.0	23.8	28.8	20.0	27.1
Anthus correndera	22	I	0	0	4.7	1.4	1.7	0.6
Sicalis luteiventris	16	G	12.3	3.2	23.8	5.1	16.5	4.0
Zonotrichia capensis	22	G (I)	1.4	0.5	0	0	0.9	0.3
Sturnella loyca	96	I (G)	4.1	6.4	12.0	15.3	7.0	10.0
Unidentified Passeriformes	49		5.5	4.3	4.7	3.1	5.2	3.8
Insects orders:			0	0	9.5	T[c]	3.5	T[c]
Odonata	1.0		0	0	2.4	T[c]	0.9	T[c]
Coleoptera	0.5		0	0	7.1	T[c]	2.6	T[c]
Total prey items			73		42		115	
Total biomass				4508		3130		7638
Total pellets			40		25		65	

[a] Mass estimates from Figueroa and Corales (1999), except for *A. correndera* and *Z. capensis* (unpubl. data).
[b] Determined from Murúa (1996) for small mammals and Estades and Temple (1999) for birds; F = frugivores, G = granivores, I = insectivores, O = omnivores. Secondary diet is given in parentheses.
[c] T = trace; values less than 1%.

Eight line transects were established during winter and three during spring–summer. The abundance of small mammals was evaluated by trapping transects (Call 1986) using medium Sherman live traps (10–15 m apart) placed in unaltered pasture and marshes. Three 10-trap transects were established in pasture during winter and three in pasture and two in marshes during spring–summer, and these were sampled for 5 nights. Thus, total effort was 351 trap-nights (nonfunctional traps were discounted).

Seasonal changes between proportions in different prey taxa in diet were evaluated with chi-square tests using contingency tables (Fowler and Cohen 1986). Only vertebrate prey were included for analysis; contribution of insects was insignificant. Geometric mean weight of prey (Marti 1987) was calculated as follows: GMW = antilog $(\Sigma n_i \log w_i / \Sigma n_i)$, where n_i was the number of individuals of the ith species and w_i was the mean weight. Only prey items identified to species level were included to estimate GMW. Differences among GMW were analyzed using *t*-tests (Fowler and Cohen 1986). To determine whether falcons took vertebrate prey selectively or opportunistically, we compared frequency distribution of prey in pellets versus prey abundance in the field using Spearman's rank correlation as recommended by Jaksic (1979) for a comparison between prey consumption and availability. Because of the small sample size for each season, we combined results of the winter and spring–summer diet for correlations.

RESULTS

Whole pellets averaged 27.3 ± 1.3 mm length × 13.3 ± 0.5 mm width and had a mean dry weight of 0.9 ± 0.08 g ($\bar{x}$ ± SE, N = 36). In total, we identified 115 prey items in the pellets including seven bird species, three rodent species, and three insect orders (Table 1). By both number and biomass, birds were the most common prey

Table 2. Relative bird abundance estimated by the line-transect method during 1997 in an agricultural field in Tricauco, Araucanía region, southern Chile. Values are pooled results of the winter and spring–summer surveys.

SPECIES	PERCENT INDIVIDUALS (%)
Eared Dove (*Zenaida auriculata*)	2.7
Black-faced Ibis (*Theristicus melanopis*)	1.8
California Quail (*Callipepla californica*)	2.1
Southern Lapwing (*Vanellus chilensis*)	20.0
Austral Parakeet (*Enicognathus ferrugineus*)	3.0
Dark-faced Ground-Tyrant (*Muscisaxicola macloviana*)	2.0
House Wren (*Troglodytes aedon*)	3.3
Austral Thrush (*Turdus falcklandii*)	11.5
Correndera Pipit (*Anthus correndera*)	4.2
Grassland Yellow-Finch (*Sicalis luteiventris*)	22.5
Rufous-collared Sparrow (*Zonotrichia capensis*)	7.6
Yellow-winged Blackbird (*Agelaius thilius*)	3.2
Long-tailed Meadowlark (*Sturnella loyca*)	4.1
Common Diuca-Finch (*Diuca diuca*)	4.3
Black-chinned Siskin (*Carduelis barbata*)	3.0
Other birds[a]	4.7
Total individuals	1782

[a] Includes all bird species that individually accounted for less than 1% in abundance.

of the Aplomado Falcon (Table 1). Passerines were the group of birds most frequently found in pellets, with Austral Thrushes (*Turdus falcklandii*) and Grassland Yellow-Finches (*Sicalis luteiventris*) being the most common prey species (Table 1). By biomass, the Austral Thrush and Eared Dove (*Zenaida auriculata*) were the most important avian prey both during winter and spring–summer. Rodents were an important part of the winter and overall diet with olivaceus field mice (*Abrothrix olivaceus*) being the most frequent (Table 1). Insects were negligible both by number and biomass.

Because of small sample size and uncertainty as to how much of each item was consumed, we did not use prey remains to quantify diet. However, feather remains confirmed that the Austral Thrush and Eared Dove were the most common prey of the Aplomado Falcon. In addition, we found elytra ($N = 40$) of the cerambycid *Acanthinodera cummingi* indicating 20 individuals.

More birds and less rodents were consumed during spring–summer as compared to the winter season ($\chi^2 = 17.4$, $P < 0.001$; Table 1). Proportions of Columbiformes and Passeriformes remained similar between seasons ($\chi^2 = 0.2$, $P > 0.05$). Global GMW were 42.0 ± 9.1 g for all prey, 51.8 ± 10.3 g for all vertebrate prey, and 63.9 ± 14.2 g for birds alone. No seasonal differences were detected in GMW for all prey combined (48.3 ± 6.1 g for winter and 37.0 ± 5.5 g for spring–summer; $t_8 = -1.3$, $P > 0.05$) or for vertebrate prey (48.3 ± 6.1 g for winter and 58.8 ± 5.6 g for spring–summer; $t_5 = 0.6$, $P > 0.05$).

For the year, we counted 1782 non-raptor birds comprising 33 species. The most numerous species were the Grassland Yellow-Finch, Southern Lapwing (*Vanellus chilensis*), Austral Thrush and Rufous-collared Sparrow (*Zonotrichia capensis*; Table 2). More birds were observed during winter (993 birds/km^2) than spring-summer (482 birds/km^2). We captured 43 rodents comprising seven species. By number, the most abundant species were the olivaceus field mouse, long-tailed rice rat (*Oligoryzomys longicaudatus*), and house mouse (*Mus domesticus*; Fig. 1). Rodent captures declined from winter (22 rodents/100 trap nights) to spring–summer (5 rodents/100 trap nights).

Only 21.2% of the potential bird prey were found in the pellets (7 out of 33). Spearman rank correlation was $r_s = 0.42$ ($P < 0.05$, $N = 33$) when all bird prey were considered; and $r_s = 0.72$ ($P < 0.01$, $N = 19$) when passerines alone were considered. Although we made no statistical correlation for rodents because low numbers of species were identified in the diet, their proportions were in close agreement with those observed in the field (Fig. 1).

DISCUSSION

As in previous studies (Hector 1985, Jiménez 1993, Montoya et al. 1997, Bó 1999), the Aplomado Falcon in Tricauco was essentially an avian predator. Our study was most comparable to Hector (1985) and Bó (1999) because it was also conducted in agricultural areas. Similar to our results, both of these studies found that during the breeding season passerines and doves were the most

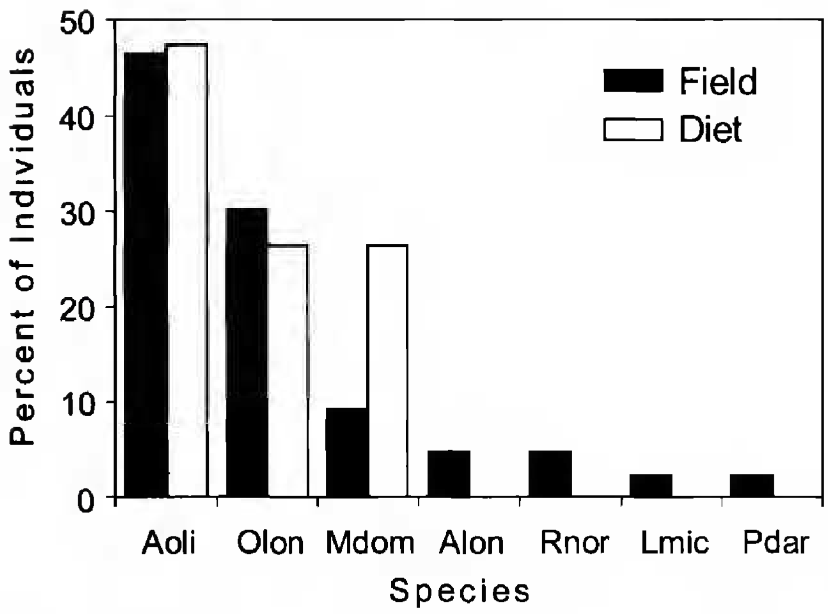

Figure 1. Comparison between the proportion of rodent prey in the Aplomado Falcon's diet versus the relative abundance in the field estimated by live-trapping during 1997 in an agricultural field in Tricauco, Araucanía region, southern Chile. Graph shows the pooled results of the winter and spring–summer diet and field trapping. Aoli = *Abrothrix olivaceus,* Olon = *Oligoryzomys longicaudatus,* Mdom = *Mus domesticus,* Alon = *A. longipilis,* Rnor = *Rattus norvegicus,* Lmic = *Loxodontomys micropus,* Pdar = *Phyllotis darwini.*

important prey for Aplomado Falcons. The small number of bird species observed in the diet in Tricauco compared to those observed during surveys in the field (Table 2) was probably a result of small sample size of pellets analyzed.

The importance of birds in the Aplomado Falcon's diet was seasonally consistent, suggesting that birds are preferred prey in spite of variability in temporal abundance in the field. The seasonal proportion of rodents in the Aplomado Falcon's diet in Tricauco was in close agreement with the results of the rodent trapping (Fig. 1). Murúa and González (1986) documented a similar oscillation for a rodent population in prairie-scrublands of southern Chile. Our data suggests that Aplomado Falcons in Tricauco could respond opportunistically to the availability of rodents that varies seasonally. It is possible that some rodent prey were taken by pirating from other raptors, as documented for Aplomado Falcons in southern Texas and northern Mexico (Brown et al. 2003), but we did not witness piracy in Tricauco.

The GMW of all prey taken during breeding season in Tricauco was greater than those reported by Hector (1981) in Mexico (23.8 g) and Bó (1999) in Argentina (25 g); this result was likely due to the higher incidence of larger prey in our study area. It is also possible that higher GMW for Tricauco was an artifact of the relatively small numbers of pellets collected during spring–summer. In general, our results suggested that Aplomado Falcons consumed most of their prey opportunistically rather than selectively (i.e., they took prey in proportion to its abundance), especially for passerine birds and rodents. However, the results also suggested that nonpasserine-avian prey may not be taken according to their abundance. Aplomado Falcons caught proportionally more doves than passerines. The Eared Dove ranked third by number in the diet, but twelfth in the field surveys. Its abundance in the diet may be explained in two ways. First, Eared Doves have greater body mass and, therefore, provide greater energetic benefits. Second, doves in large flocks frequently used cultivated fields during the winter when cereal seeds were more available (Bucher and Orueta 1977), possibly making this species more vulnerable to predation. In addition, Aplomado Falcons may have captured doves when they were roosting in trees (Hector 1986).

The Aplomado Falcon's apparent selection of Eared Doves was further indicated by the fact that no Southern Lapwings (body mass = 270 g) were found in the falcon's diet. The Southern Lapwing is a conspicuous ground-dwelling bird and was the second most abundant species in the field (356 individuals, 20% in number). We suggest that their aggressive defensive behaviour prevented the falcons from preying upon lapwings. When menaced by a potential predator, Southern Lapwings simulate attacks by exhibiting their wing-spurs and emitting strident vocalizations (Walters 1990).

Regarding passerine prey, the rate of consumption of Austral Thrushes and Grassland Yellow-Finches were consistent with their abundance in the field, but was probably accentuated by their conspicuousness. Similar to Eared Doves, both species moved actively in large flocks when searching for food on cultived fields. Although the Grassland Yellow-Finch was the smallest passerine available (16 g), its abundance in open fields may have compensated for its small caloric value. Like Jiménez (1993), we found that Aplomado Falcons generally took more seed-eating than insectivorous birds (6:1; see Table 1) Thus, Aplomado Falcons may be less affected by organochlorine pesticides in the agricultural fields of Chile than in Mexico (Kiff et al. 1980).

Our examination of other vegetative-cover types suggested that agricultural fields offer a wide variety of appropriately-sized prey of which Aplomado Falcons can exploit selectively or opportunistically in southern Chile. However, our inferences must be limited because of the small sample size of pellets and the restricted study area considered. More data using appropriate methods to study dietary and foraging habits of Aplomado Falcons should clarify the relationships suggested by our study.

DIETA ESTASIONAL DE *FALCO FEMORALIS* EN UN ÁREA AGRÍCOLA DE ARAUCANÍA, SUR DE CHILE

RESUMEN.—La dieta del halcón *Falco femoralis* fue cuantificada sobre la base de 65 regurgitados colectados durante 1997 en un área agrícola del sur de Chile. Las aves fueron el núcleo de la dieta (58–88% por número, 84–

99% por biomasa), siendo *Turdus falcklandii, Sicalis luteiventris* y *Zenaida auriculata* las presas más importantes. Los roedores fueron importantes en la dieta invernal (43% por número, 16% por biomasa), pero disminuyeron notoriamente en primavera-verano, coincidiendo con la abundancia estacional de roedores en el campo. El peso medio geométrico fue 42.0 ± 9.1 g para todas las presas y 51.8 ± 10.3 g para las presas vertebradas. Estos valores son más altos a los reportados por otros autores y sería una consecuencia de la mayor incidencia de presas grandes en nuestra área de estudio. El halcón perdiguero consumió una importante fracción de sus aves presa de acuerdo a nuestras estimaciones de abundancia en el campo (r_s = 0.42, $P < 0.05$). Las tórtolas, sin embargo, fueron consumidas en mayor proporción que los paserinos. Esto sugiere que el halcón perdiguero en Tricauco se comportaría como un depredador parcialmente selectivo.

[Traducción de los autores]

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MESOSTIGMATIC MITES (ACARI: MESOSTIGMATA) IN WHITE-TAILED SEA EAGLE NESTS (*HALIAEETUS ALBICILLA*)

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KEY WORDS: *White-tailed Sea Eagle;* Haliaeetus albicilla; *nest biology; mites; Mesostigmata; Poland.*

Although studies on mites living in bird nests were first carried out 70 yr ago (Nordberg 1936), knowledge on mite communities in this microhabitat is largely inadequate. Recently, the acarofauna of small passerine nests have been studied including detailed studies on Great Reed Warbler (*Acrocephalus arundinaceus*), Reed Warbler (*A. scirpaceus*), Penduline Tit (*Remiz pendulinus*), and Red-backed Shrike (*Lanius collurio*; Mašan and Krištofík 1995, Krištofík et al. 2001, Tryjanowski et al. 2001). However, information about mites occurring in bird nests is still fragmentary, especially in reference to the acarofauna of raptor nests (e.g., Philips 1981, 2000, Philips et al. 1983,

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